PATENT SPECIFICATION 798,144

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International Classification :—G01n.

COMPLETE SPECIFICATION.

Method of and Apparatus for Optically Detecting the Presence of Solid Material in Transparent Liquids.

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to methods of, and apparatus for, optically detecting the presence of small particles of solid material in transparent liquids contained within transparent containers, such as ampoules, jars, bottles and the like. For the purposes of this Specification the term "transparent" includes any translucent container or liquid that is sufficiently transparent to permit the presence of small solid particles in the liquid to be detected optically by shining a sufficiently strong beam of light through the container and liquid.

The invention is especially, though not exclusively, concerned with methods of, and apparatus for, detecting the presence of foreign bodies in the form of small particles of solid material in medicinal liquids contained within sealed ampoules, for example liquids required for hypodermic injection and like purposes. Such ampoules usually consist of small tubular glass containers which are partly filled with the liquid through one end of the container, which is tapered, and then sealed off by fusing the tapered end. It occasionally happens that small spicules, thought to be of glass are formed inside the ampoule after the sealing operation, and especially after subsequent heat treatments when employed, for example for sterilising; also small particles of other solid material sometimes pass into the ampoules together with the liquid, for example particles dislodged from the filter arrangements in the filling mechanism.

The filled ampoules must therefore be examined after sealing in order that those containing such foreign bodies can be rejected, and such examination is usually effected by shining a beam of light through the container and liquid so that any small particles of solid material in the liquid will reflect light and thereby be rendered visible.

The main object of this invention is to provide an improved method of detecting the presence of such foreign bodies and a novel form of apparatus for the application of the method, the apparatus being suitable for use in the mass production of such tubular ampoules. The method and apparatus of the invention can, however, be applied to the detecting of solid particles in transparent liquids in other forms of container having an axis of rotational symmetry.

According to the invention, a method of detecting the presence of small particles of solid material in a transparent liquid within a transparent container having an axis of rotational symmetry includes the steps of rapidly rotating the container so as to cause the liquid to swirl round within the container in one direction about a vertical axis and then rotating the container relatively slowly in the opposite direction about its axis of rotational symmetry whilst this axis is held vertical or nearly vertical and whilst shining a beam of light into the container and liquid, so that any particles of solid material present in the body of the liquid are rendered visible by light reflected from the particles.

The first rotation of the container preferably consists of a rapid spinning about its vertically-held axis rotational symmetry, and

[*Price* 3*s.* 6*d.*]

Price 25p

this rotation can in general be arranged to be so rapid as to cause particles of solid material resting loosely on the bottom of the container to be carried up into the body of the liquid. However, it should not in general be so rapid that gas bubbles are drawn into the liquid from the air or other gas present in the container together with the liquid, since the presence of such gas bubbles may interfere with the detection of the solid particles.

The purpose of the second, relatively slow, counter-rotation of the container is to give particles which are carried by the container but are not loose within it, for example particles on the outer surface of the container or embedded in its walls, a component of motion opposite to that of the particles within the liquid so as to render the latter readily distinguishable. In some cases it is desirable to incline the axis during this rotation at a few degrees to the vertical for avoiding disturbing light reflections from the container walls.

An apparatus for applying the method of the invention in the manufacture of transparent containers having an axis of rotational symmetry and containing a transparent liquid may include an endless-belt conveyor which carries at each of a plurality of spaced points a bearing containing a holder arranged for rotation about a vertical axis, each holder being arranged to carry a container fixed relatively to the holder with its axis of rotational symmetry substantially in line with the holder axis, spinning means arranged for imparting to each holder, as it is carried past the spinning means by the conveyor, a rapid rotation in one direction about the axis of the holder, turning means arranged adjacent to the spinning means for imparting to each holder after passing the spinning means a relatively slow rotation in the opposite direction about the axis of the holder, this motion continuing whilst the holder traverses an inspection zone, and a light source arranged for shining light into the liquid-filled container as it traverses the inspection zone so as to render visible any solid particles which are present within the liquid, visible by light reflected from the particles.

Preferably each holder of the conveyor is mounted for free rotation in its bearing and carries a turning wheel attached to a vertical shaft-part of the holder, the spinning means is positively driven and is arranged momentarily to engage said turning wheel for imparting a rapid rotation to the holder, and the turning means includes a static friction pad so placed that it leans against the turning wheel of each holder as the holder is carried past and causes it to rotate.

The invention will be further explained in describing, by way of example, one embodiment of it which is illustrated in the schematic drawings accompanying the Provisional Specification in which:—

Figure 1 shows a front view of the general details of a conveyor designed for the inspection of medicinal ampoules;

Figure 2 shows a section through one of the ampoule holders engaging the spinning means; and

Figure 3 shows the details of the optical arrangement which has been largely omitted from Figure 1 for the sake of clarity.

In this embodiment the conveyor has a rigid frame 1 from the upper part of which project shafts on which are rotatably mounted a plurality of belt drums of which two, namely 2 and 3, appear in Figure 1. Around these is fitted a flexible belt 4 which forms a closed horizontal loop with the faces of the belt substantially vertical. The belt drums are free running except for one, namely 2 in Figure 1, which is driven from an electric motor 5 through reduction gearing 6.

At regularly spaced points the belt 4 carries bearings 7 for rotatable ampoule holders 8, two of which are shown in Figure 1, each carrying an ampoule 9. From the upper part of each ampoule holder extends a shaft 10 to which is keyed a horizontal turning wheel 11.

At the front of the conveyor is arranged a guide plate 12, attached to the frame 1, across the front face of which plate the belt 1 is arranged to pass and which is fitted with guide flanges 13 which lap over the edges of the belt for guiding its passage relatively to the spinning means and turning means of the conveyor.

The spinning means comprises a horizontal driving wheel 14 which is keyed to a vertical shaft 15 mounted in bearings (not shown) attached to the frame 1 and arranged to be driven from the motor 5 by a belt drive from a vertical pulley wheel 5*a* carried by the motor shaft to a smaller pulley wheel 16 carried by the shaft 15, giving a step-up in shaft speed of rotation.

The front edge of the driving wheel 14 projects through an aperture in the guide plate 12 at the centre of a gap in the upper guide flange 13 and is positioned to engage the turning wheel 11 of each holder as the latter is carried across the gap by the belt 4.

For maintaining the engagement of the turning wheels 11 with the driving wheel 14 against the flexibility of the belt, the spinning means includes also a free-running roller 17 mounted in a bearing 18 carried on a spring-loaded arm 19 attached to the upper part of the conveyor frame 1. The roller 17 is positioned so as to engage with the opposite side of each turning wheel 11 as the latter is carried into engagement with the driving wheel 14 and to maintain the

engagement by virtue of its spring loading.

This arrangement is shown in more detail in Figure 2, which shows a vertical section through the relevant parts looking from the left in Figure 1. This Figure shows the rubber facings 20 and 21 which are provided on the driving wheel 14 and roller 17, respectively, for increasing the frictional engagement with the turning wheel 11. Bearing bushes 22 for the shaft 10 in the bearing 7 are shown and the details of the holders 8 and ampoules 9 are indicated more clearly in this Figure.

Each ampoule 9 consists of a thin-walled glass tube the upper part of which is necked and tapered beyond the neck to where it is sealed off. The ampoule is filled with liquid to just below the level of the neck.

Each holder 8 consists of a hollow cylinder dimensioned to fit closely round the upper part of an ampoule and having three symmetrically spaced vertical slots over each of which is fitted a vertical retaining spring 23 having a cranked lower end which enters into the slot and is designed to fit into the neck of an ampoule and help to hold it firmly in position when the upper end of the ampoule is inserted upwards into the holder.

The turning means of the conveyor consists of an elongated static friction pad 24 attached to the front of the guide plate 12 and positioned to engage with the turning wheel 11 of each holder after the latter has passed the driving wheel 14.

The optical means of the apparatus, which is represented in Figure 1 merely by the lamp 25 and will be further described later, is arranged to shine an intense beam of light into each ampoule as the latter is carried by its holder along the inspection zone defined by the length of the friction pad 24.

The motor 5 is provided with a speed control for enabling each ampoule holder to be brought quickly up to the driving wheel 14, where a rapid spin is imparted to it by the driving wheel 14 in a clockwise direction looking down from above in the arrangement illustrated in Figure 1, and then quickly up to the friction pad 24, where the speed of the motor is reduced so as to cause the holder to traverse the inspection zone relatively slowly, the engagement of the turning wheel 11 of the holder with the pad 24 during this traversal reversing the direction or rotation of the holder whilst the liquid within the ampoule continues to swirl round in the original clockwise direction. Particles which may be floating in the liquid, which are rendered visible by light from the lamp 25 reflected by the particles to the operator, can thereby be readily distinguished from particles moving with the glass wall of the ampoule, for example particles on its outer surface.

The speed of the motor is then increased to bring the next ampoule up for spinning and inspection.

The motor is also provided with a reversing switch so that in case of doubt an ampoule can be brought back to the spinning means for the above process to be repeated.

Rejected ampoules can be readily detached by the operator from their holders, and satisfactory ampoules permitted to pass on to an unloading station, which may also serve as a loading station for the conveyor, or a separate loading station can be used if desired.

Turning now to Figure 3, this shows schematically the details of a preferred form of optical means for ampoules of the shape illustrated. The Figure represents a vertical section through the inspection zone looking from the right in Figure 1, but showing only the relevant parts. The Figure shows an ampoule 9 being carried in its holder 8 along the inspection zone with the turning wheel 11 of the holder in engagement with the friction pad 24, this engagement being assisted, and the axis of the ampoule being inclined, with its upper end backwards, at an angle of about 5° to the vertical, by the engagement of the lower part of the belt 4 with a ramp 26 projecting from the guide plate 12. This inclination of the ampoule is in particular designed to avoid strong reflections of the light from the lamp 25 reaching the eye of the observer, indicated at 27, from the walls of the ampoule.

The lamp 25 is shown as a sodium vapour electric discharge lamp having a U-shaped discharge envelope arranged just in front of a vertical plane through the front edge of the base of the ampoule, and with the plane containing the limbs of the discharge envelope tilted so that both limbs are presented to the base of the ampoule.

For providing a dead black background against which the ampoules can be viewed, a forwardly tilted background screen 28 is provided having a shiny black surface, together with a lower facing light trap screen 29 having a matt black surface.

Vertical screens 30 and 31 are provided for preventing light from the lamp 25 passing directly to the eye 27 of the observer or to the background screen 28, and for facilitating the observation of the ampoules a large lens 32, for example of moulded transparent thermoplastic material, is provided, giving a magnified binocular view of the ampoules as they are carried across the inspection zone.

It will be appreciated that other optical arrangements may be more suitable with ampoules of other shape, and that the light source used need not necessarily be a sodium lamp. In some cases it may be necessary

to choose a light source of a particular colour suited to the colour of the liquid contained within the ampoules or other containers which may be used.

It will be further appreciated that the speed control of the motor in the embodiment described and illustrated could, if desired, be effected automatically in response to the movement of the holders, for example by the action of suitable cams and switches.

WHAT WE CLAIM IS:—

1. A method of optically detecting the presence of small particles of solid material in a transparent liquid within a transparent container having an axis of rotational symmetry which method includes the steps of rapidly rotating the container so as to cause the liquid to swirl round within the container in one direction about a vertical axis and then rotating the container relatively slowly in the opposite direction about its axis of rotational symmetry whilst this axis is held vertical or nearly vertical and whilst shining a beam of light into the container and liquid, so that any particles of solid material present within the body of the liquid are rendered visible by light reflected from the particles.

2. A method according to Claim 1 wherein the first rotation of the container consists of a rapid spinning about its vertically-held axis of rotational symmetry.

3. An apparatus for carrying out the method according to Claim 1 or 2 including an endless belt conveyor which carries at each of a plurality of spaced points a bearing containing a holder arranged for rotation about a vertical axis, each holder being arranged to carry a said container fixed relatively to the holder with its axis of rotational symmetry substantially in line with the holder axis, spinning means arranged for imparting to each holder, as it is carried past the spinning means by the conveyor, a rapid rotation in one direction about the axis of the holder, turning means arranged adjacent to the spinning means for imparting to each holder after passing the spinning means a relatively slow rotation in the opposite direction about the axis of the holder, this motion continuing whilst the holder traverses an inspection zone, and a light source arranged for shining light into the liquid-filled container as it traverses the inspection zone for rendering visible by light reflected from the particles any solid particles which are present within the liquid.

4. An apparatus according to Claim 3 in which each holder of the conveyor is mounted for free rotation in its bearing and carries a turning wheel attached to a vertical shaft-part of the holder, and the spinning means includes a positively driven wheel arranged to engage the turning wheel of each holder as the holders are carried past the spinning means.

5. An apparatus according to Claim 3 in which each holder of the conveyor is mounted for free rotation in its bearing and carries a turning wheel attached to the vertical shaft-part of the holder and wherein the turning means comprises or includes a stationary friction pad so placed that it bears against the turning wheel of each holder as the holders are carried past the turning means.

6. Apparatus for optically detecting the presence of small solid particles in transparent liquids contained within transparent containers, constructed and arranged to operate substantially as shown in, and as hereinbefore described with reference to, the drawing accompanying the Provisional Specification.

For the Applicants,
J. E. M. HOLLAND,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION.

Method of and Apparatus for Optically Detecting the Presence of Solid Material in Transparent Liquids.

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, do hereby declare this invention to be described in the following statement:—

This invention relates to methods of, and apparatus for, optically detecting the presence of small particles of solid material in transparent liquids contained within transparent containers, such as ampoules, jars, bottles and the like. For the purposes of this Specification the term "transparent" includes any translucent container or liquid that is sufficiently transparent to permit the presence of small solid particles in the liquid to be detected optically by shining a sufficiently strong beam of light through the container and liquid.

The invention is especially, though not exclusively, concerned with methods of, and apparatus for, detecting the presence of foreign bodies in the form of small particles of solid material in medicinal liquids contained within sealed ampoules, for example liquids required for hypodermic injection and like purposes. Such ampoules usually

consist of small tubular glass containers which are partly filled with the liquid through one end of the container, which is tapered, and then sealed off by fusing the tapered end. It occasionally happens that small spicules, thought to be of glass, are formed inside the ampoule after the sealing operation, and especially after subsequent heat treatments when employed, for example for sterilising; also small particles of other solid material sometimes pass into the ampoules together with the liquid, for example particles dislodged from the filter arrangements in the filling mechanism.

The filled ampoules must therefore be examined after sealing in order that those containing such foreign bodies can be rejected, and such examination is usually effected by shining a beam of light through the container and liquid so that any small particles of solid material in the liquid will reflect light and thereby be rendered visible.

The main object of this invention is to provide an improved method of detecting the presence of such foreign bodies than can readily be applied to provide a novel form of apparatus suitable for use in the mass production of such tubular ampoules. The method and apparatus of the invention can, however, be applied to the detecting of solid particles in transparent liquids in other forms of container having an axis of rotational symmetry.

According to the invention, a method of optically detecting the presence of small particles of solid material in a transparent liquid within a transparent container having an axis of rotational symmetry includes the steps of rapidly rotating the container so as to cause the liquid to swirl round within the container in one direction about a vertical axis and then rotating the container relatively slowly in the opposite direction about its axis of rotational symmetry whilst said axis is held vertical or nearly vertical and whilst shining a beam of light into the container and liquid so that particles of solid material if present in the body of the liquid are rendered visible by light reflected from the particles.

The first rotation of the container preferably consists of a rapid spinning about its vertically held axis of rotational symmetry, and this rotation can in general be arranged to be so rapid as to cause particles of solid material resting loosely on the bottom of the container to be carried up into the body of the liquid. However, it should not in general be so rapid that gas bubbles are drawn into the liquid from the air or other gas present in the container together with the liquid, since the presence of such gas bubbles might interfere with the detection of the solid particles.

The purpose of the second, relatively slow, counter-rotation of the container is to give particles which are carried by the container but are not loose within it, for example particles on the outer surface of the container or embedded in its walls, a component of motion opposite to that of the particles within the liquid so as to render the latter readily distinguishable. The axis of the container for this counter-rotation is preferably held vertical or nearly vertical, it being in some cases desirable to incline the axis at a few degrees to the vertical for avoiding disturbing light reflections from the container walls.

An apparatus for applying the method of the invention in the manufacture of transparent containers having an axis of rotational symmetry and containing a transparent liquid may include an endless-belt conveyor which carries at each of a plurality of spaced points a bearing containing a holder arranged for rotation about a vertical axis, each holder being arranged to carry a said container fixed relatively to the holder with its axis of rotational symmetry substantially in line with the holder axis, spinning means arranged at a point fixed relatively to the conveyor for imparting to each holder, as it is carried past the spinning means by the conveyor, a rapid rotation in one direction about the axis of the holder, turning means arranged at an adjacent region of and fixed relatively to the conveyor for imparting to each holder after passing the spinning means a relatively slow rotation, in the opposite direction about the axis of the holder, continuing whilst the holder traverses an inspection zone of the conveyor, and a light source arranged for shining light into the liquid-filled container carried by the holder as the latter traverses said inspection zone so as to render solid particles, if present within the liquid, visible by light reflected from the particles.

Preferably each holder of the conveyor is mounted for free rotation in its bearing and carries a turning wheel attached to a vertical shaft-part of the holder, the spinning means is positively driven and is arranged momentarily to engage said turning wheel for imparting a rapid rotation to the holder, and the turning means includes a static friction pad against which the turning wheel is arranged to bear so as to be caused to rotate as a result of the friction in conjunction with the movement of the conveyor.

The invention will be further explained in describing, by way of example, one embodiment of it which is illustrated in the accompanying schematic drawings, in which:—

Figure 1 shows a frontal view of the general details of a conveyor designed for the inspection of medicinal ampoules;

Figure 2 shows a section through one of

the ampoule holder arrangements in engagement with the spinning means; and

Figure 3 shows the details of the optical arrangement, which has been largely omitted from Figure 1 for the sake of clarity.

In this embodiment the conveyor has a rigid frame 1 from the upper part of which project shafts on which are rotatably mounted a plurality of belt drums of which two, namely 2 and 3, appear in Figure 1. Around these is fitted a flexible belt 4 which forms a closed horizontal loop with the faces of the belt substantially vertical. The belt drums are free running except for one, namely 2 in Figure 1, which is arranged to be positively driven from an electric motor 5 through reduction gearing 6.

At regularly spaced points the belt 4 carries bearings 7 for rotatable ampoule holders 8, two of which are shown in Figure 1 each carrying an ampoule 9. From the upper part of each ampoule holder extends a shaft 10 to which is keyed a horizontal turning wheel 11.

At the front of the conveyor is arranged a guide plate 12, attached to the frame 1, across the front face of which plate the belt 1 is arranged to pass and which is fitted with guide flanges 13 which lap over the edges of the belt for guiding its passage relatively to the spinning means and turning means of the conveyor.

The spinning means comprises a horizontal driving wheel 14 which is keyed to a vertical shaft 15 mounted in bearings (not shown) attached to the frame 1 and arranged to be driven from the motor 5 by a belt drive from a vertical pulley wheel 5*a* carried by the motor shaft to a smaller pulley wheel 16 carried by the shaft 15, giving a step-up in shaft speed of rotation.

The front edge of the driving wheel 14 projects through an aperture in the guide plate 12 at the centre of a gap in the upper guide flange 13 and is positioned to engage with the turning wheel 11 of each holder as the latter is carried across the gap by the belt 4.

For maintaining the engagement of the turning wheels 11 with the driving wheel 14 against the flexibility of the belt, the spinning means includes also a free-running roller 17 mounted in a bearing 18 carried on a spring-loaded arm 19 attached to the upper part of the conveyor frame 1. The roller 17 is positioned so as to engage with the opposite side of each turning wheel 11 as the latter is carried into engagement with the driving wheel 14 and to maintain the engagement by virtue of its spring loading.

This engagement is shown in more detail in Figure 2, which shows a vertical section through the relevant parts looking from the left in Figure 1. This Figure shows the rubber facings 20 and 21 which are provided on the driving wheel 14 and roller 17, respectively, for increasing the frictional engagement with the turning wheel 11. Bearing bushes 22 for the shaft 10 in the bearing 7 are shown and the details of the holders 8 and ampoules 9 are indicated more clearly in this Figure.

Each ampoule 9 consists of a thin-walled glass tube the upper part of which is necked and tapered beyond the neck to where it is sealed off. The ampoule is filled with liquid to just below the level of the neck.

Each holder 8 consists of a hollow cylinder dimensioned to fit closely round the upper part of an ampoule and having three symmetrically spaced vertical slots over each of which is fitted a vertical retaining spring 23 having a cranked lower end which enters into the slot and is designed to fit into the neck of an ampoule and help to hold it firmly in position when the upper end of an ampoule is inserted upwards into the holder.

The turning means of the conveyor consists of an elongated static friction pad 24 attached to the front of the guide plate 12 and positioned to engage with the turning wheel 11 of each holder after the latter has passed the driving wheel 14.

The optical means of the apparatus, which is represented in Figure 1 merely by the lamp 25 and will be further described later, is arranged to shine an intense beam of light into each ampoule as the latter is carried by its holder along the inspection zone defined by the length of the friction pad 24.

The motor 5 is provided with a speed control for enabling each ampoule holder to be brought quickly up to the driving wheel 14, where a rapid spin is imparted to it by the driving wheel 14 in a clockwise direction looking down from above in the arrangement illustrated in Figure 1, and then quickly up to the friction pad 24, where the speed of the motor is reduced so as to cause the holder to traverse the inspection zone relatively slowly, the engagement of the turning wheel 11 of the holder with the pad 24 during this traversal reversing the direction of rotation of the holder whilst the liquid within the ampoule continues to swirl round in the original clockwise direction. Particles floating in the liquid, which if present are rendered visible by light from the lamp 25 reflected by the particles to the operator, can thereby be readily distinguished from particles moving with the glass wall of the ampoule, for example particles on its outer surface.

The speed of the motor is then increased to bring the next ampoule up for spinning and inspection.

The motor is also provided with a reversing switch so that in case of doubt an ampoule can be brought back to the spinning

means for another spinning and subsequent inspection with counter-turning.

Reject ampoules can be readily detached by the operator from their holders, and satisfactory ampoules permitted to pass on to an unloading station, which may also serve as a loading station for the conveyor, or a separate loading station can be used if desired.

Turning now to Figure 3, this shows schematically the details of a preferred form of optical means for ampoules of the shape illustrated. The Figure represents a vertical section through the inspection zone looking from the right in Figure 1, but showing only the relevant parts. The Figure shows an ampoule 9 being carried in its holder 8 along the inspection zone with the turning wheel 11 of the holder in engagement with the friction pad 24, this engagement being assisted, and the axis of the ampoule being inclined, with its upper end backwards, at an angle of about 5° to the vertical, by the engagement of the lower part of the belt 4 with a ramp 26 projecting from the guide plate 12. This inclination of the ampoule is in particular designed to avoid strong reflections of the light from the lamp 25 reaching the eye of the observer, indicated at 27, from the walls of the ampoule.

The lamp 25 is shown as a sodium vapour electric discharge lamp having a U-shaped discharge envelope arranged just in front of a vertical plane through the front edge of the base of the ampoule, and with the plane containing the limbs of the discharge envelope tilted so that both limbs are presented to the base of the ampoule.

For providing a dead black background against which the ampoules can be viewed, a forwardly tilted background screen 28 is provided having a shiny black surface, together with a lower facing light trap screen 29 having a matt black surface.

Vertical screens 30 and 31 are provided for preventing light from the lamp 25 passing directly to the eye 27 of the observer or to the background screen 28, and for facilitating the observation of the ampoules, a large lens 32, for example of moulded transparent thermoplastic material, is provided giving a magnified binocular viewing of the ampoules as they are carried across the inspection zone.

It will be appreciated that other optical arrangements may be more suitable with ampoules of other shape, and that the light source used need not necessarily be a sodium lamp. In some cases it may be necessary to choose a light source of a particular colour suited to the colour of the liquid contained within the ampoules, or other containers as may be used in any particular case.

It will be further appreciated that the speed control of the motor in the embodiment described and illustrated could, if desired, be arranged to be effected automatically in response to the movement of the holders, for example by the action of suitable cams and switches.

For the Applicants,
J. E. M. HOLLAND,
Chartered Patent Agent.

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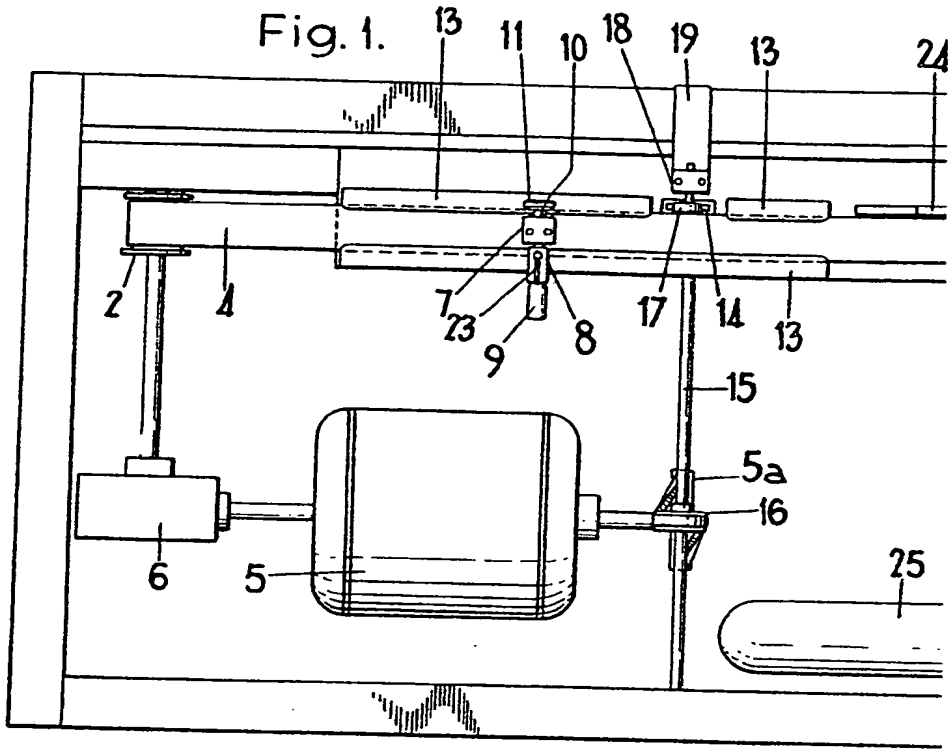
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.

Fig. 1.



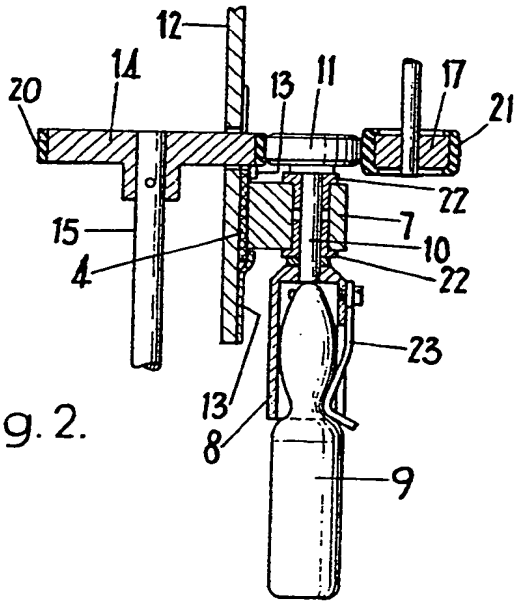


Fig. 2.

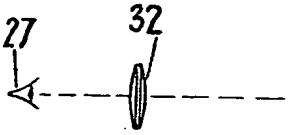
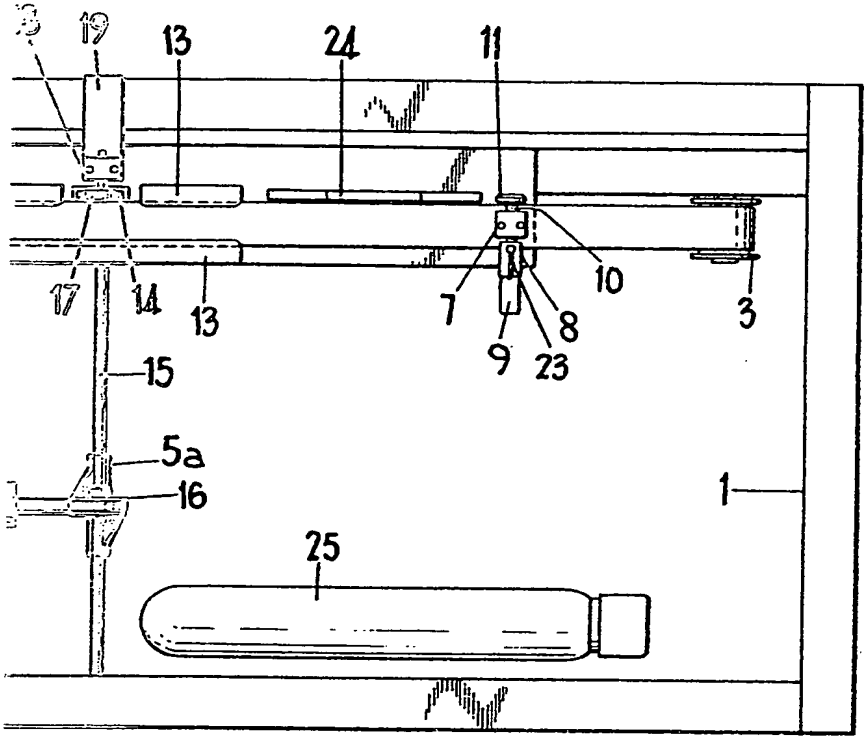


Fig. 3.

798,144 PROVISIONAL SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.



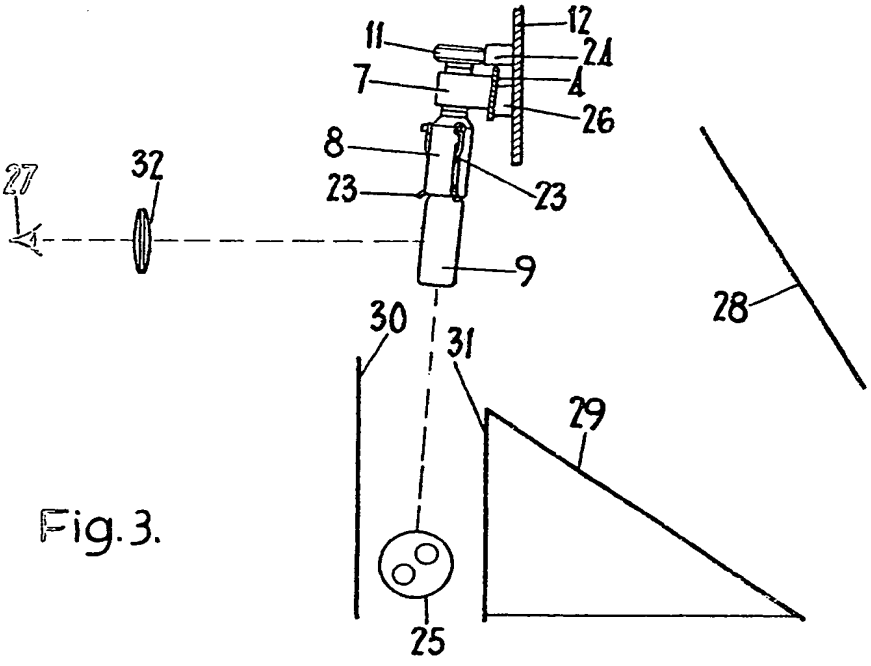
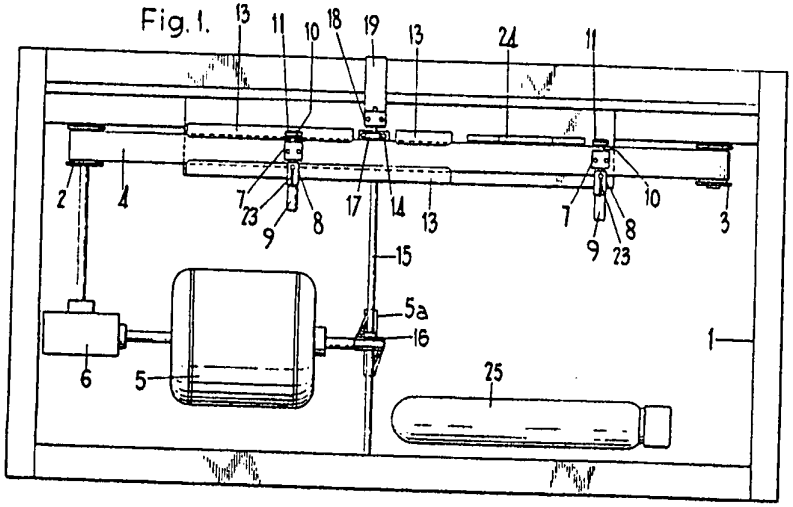


Fig. 3.

798,144 PROVISIONAL SPECIFICATION
1 SHEET

Fig. 1.



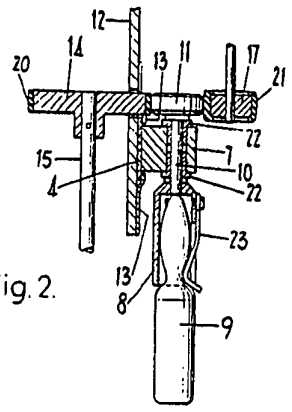


Fig. 2.

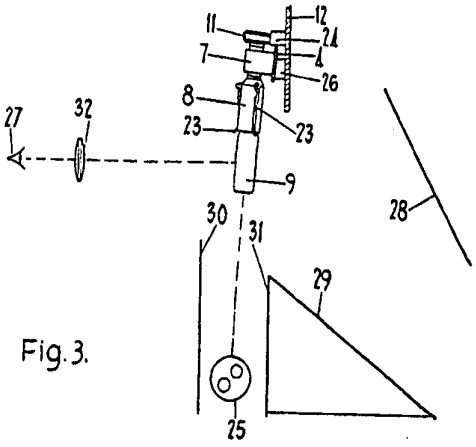


Fig. 3.